Joint Transportation Research Program

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Evaluation of Alternatives to Sound Barrier Walls

Introduction

The present INDOT Traffic Noise Policy was distributed in January of 2007, and applies solely to Type I projects. The noise wall is considered to be cost-effective when a 5 dBA reduction can be achieved at a cost of no more than $25,000 per benefited receiver for new development or $30,000 per benefited receiver in those cases where a majority of the receivers were in place prior to construction of the highway. In many areas, the above cost-effectiveness criteria are exceeded with the result that the areas are not eligible for federal-aid funding for noise abatement. Consequently, the residents in these areas are dissatisfied that no noise reduction measures are provided to them. Line of sight (LOS) wall refers to a wall that is just tall enough to break the horizontal line of sight between the roadway and homes. While the LOS wall does not fit into the current noise wall policy and could not use federal funds for construction, it may provide a mitigating measure to improve customer satisfaction at a less expensive cost than conventional noise walls. In addition, the current INDOT noise policy does not allow for private funds to be used to reduce the cost per receiver. The main objectives of this research project are to conduct a synthesis of other DOTs' traffic noise policies, to conduct surveys assessing customer satisfaction with LOS walls and to evaluate the performance of different LOS walls.

Findings

State DOT Traffic Noise Policies

Fourteen state DOTs opt to participate in Type II projects. In the Midwest, Illinois, Michigan, and Ohio have participated in Type II projects. Wisconsin has established the WisDOT Retrofit Noise Barrier Program that consists of a list of state-funded, stand-alone noise abatement projects on existing highways. Forty-three state DOTs use the allowable cost per benefited receptor. Seven state DOTs utilize the maximum square footage per benefited receptor to measure the cost-effectiveness. No state DOTs in the Midwest use the maximum square footage per benefited receptor currently. Several state DOTs allow the use of third party funding in some special situations. Third party funding is mainly used to construct noise abatement measures within the State right-of-way for either Type II projects or retrofit projects.

Construction, Cost, and Structural Evaluation

The construction cost of noise walls included three pay items, including barrier design and layout, barrier panels, and panel erection. For the conventional Durisol precast concrete noise wall, the three pay items accounted for 2.8%, 75.8%, and 21.4% of the total cost, respectively. For the LOS walls, the three pay items shared on average 10.1%, 62.9%, and 27.0% of the total construction cost, respectively. The unit cost for LOS walls ($30/ft^2) was more than that for the Durisol precast concrete wall ($23.4/ft^2). This is because the competitive bids for the LOS walls were not available due to the small amount of work. Also, the foundation for the Durisol precast concrete wall was utilized for the LOS walls.

Pre- and Post-installation Noise Levels

In NSA1 (LOS walls, Temple Ave.), the pre-installation noise levels at all 23 homes varied from 55.5 dBA to 71.7 dBA with an average of 65.0 dBA. The post-installation noise levels dropped to 50.6–67.0 dBA with an average of 60.2 dBA. The noise reduction varied between 2.5 dBA and 12.2 dBA with an average of 4.8 dBA. Also, 63.6% of the impacted homes received a noise reduction ≥5 dBA, which indicates that the LOS walls are acoustically feasible.

In NSA2 (conventional Durisol noise wall, Retreat Apt), the pre-installation noise levels ranged between 63.2 dBA and 73.2 dBA with an average of 68.2 dBA. The post-installation noise levels varied between 57.8 dBA and 65.6 dBA with an average of 62.0 dBA. The noise reduction varied from 3.3 dBA to 7.9 dBA with an average of 6.1 dBA. For the impacted homes, 75.0% received a noise reduction ≥5 dBA. In NSA3 (conventional Durisol noise walls, East 101

St.), the pre-installation noise levels ranged between 60.5 dBA and 69.9 dBA with an average of 65.5 dBA. The post-installation noise levels varied between 58.0 dBA and 64.0 dBA with an average of 61.6 dBA. The noise reduction varied from 3.3 dBA to 7.9 dBA with an average of 6.1 dBA.

Psychoacoustic-based Noise Wall Effectiveness Evaluation

The conventional Durisol noise wall is more effective in noise reduction. The height of the Durisol noise wall could affect its noise reduction capability. The shorter the Durisol noise wall, the less effective the noise reduction, especially in higher frequency bands. The LOS walls are less effective than the Durisol noise wall. However, LOS walls can reduce some noise impact. Among AAC, Noise D-Fence, and Sanders Precast walls, AAC wall is less effective than Noise D-Fence and Sanders Precast walls. Based on the psychoacoustic annoyance, Sanders Precast walls can perform slightly better than Noise D-Fence walls in noise reduction.

Pre- and Post-installation Community Noise Surveys

The survey respondents received a perceivable noise reduction after the installation of noise walls. The greater noise reduction was perceived in NSA2 and NSA3 with conventional noise walls than in NSA1 with LOS walls. The installation of noise walls have also improved both safety and security for kids playing in their backyards. In NSA2 and NSA3, 53% of the respondents were pleased with appearance of the conventional noise wall. In NSA1 with the LOS walls, half of the respondents were displeased with appearance of the LOS walls. For these respondents displeased with the appearance of the LOS walls, 70% responded that the LOS walls should be either higher or longer. The waviness occurred in the outer skin on the Noise D-Fence wall had adverse impact on the respondents' perceptions of the appearance of the LOS walls.

About 66% of the respondents indicated that noise walls should be built even if the cost-effective threshold is exceeded. About 18% of the respondents would accept a cheap alternative to provide some noise reduction. Also, 82% of the respondents expressed no willingness to contribute money if the cost-effective threshold is exceeded. Of those respondents willing to contribute money, the average amount of money they would like to pay is $2,160. About 54% of the respondents indicated that alternative walls with limited noise reduction should be built even if the cost-effective threshold is exceeded.

Prediction and Analysis of Traffic Noise over Design Year

The pre-installation noise levels predicted with DGAC, OGAC, and Average pavements are respectively 2.9 dBA, 3.5 dBA and 2.0 dBA less than that with PCC. However, the noise differences due to the pavement type become less after installing the noise walls. The noise level increases by 5 dBA as traffic speed increases from 50 mph to 75 mph. The effect of traffic speed on the noise level is independent of the ground condition to some extent. The effect of traffic volume on the noise level is also independent of the ground condition. The effct of NRC on the noise level is negligible. As the noise wall height increases from 10 ft. to 24 ft., the noise level decreases by about 5.6 dBA. However, the decrease rate drops as the noise wall height increases, particularly when the noise wall exceeds 16 feet high. The effectiveness of noise reduction by increasing the noise wall height also varies with the receptor's distance and elevation. The noise reduction decreases as the distance increases or the elevation decreases.

Making the Sanders or AAC noise walls longer may not provide noise reduction as much as expected at those houses living close to the ends of LOS walls. After installing the noise walls, most of the receivers are well outside the N66 noise contours. In the end of the design year, only 33% of the receivers in NSA1, 56% of the receivers in NSA2, and 100% of the receivers in NSA3 can achieve a noise reduction of 5 dBA or more.

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